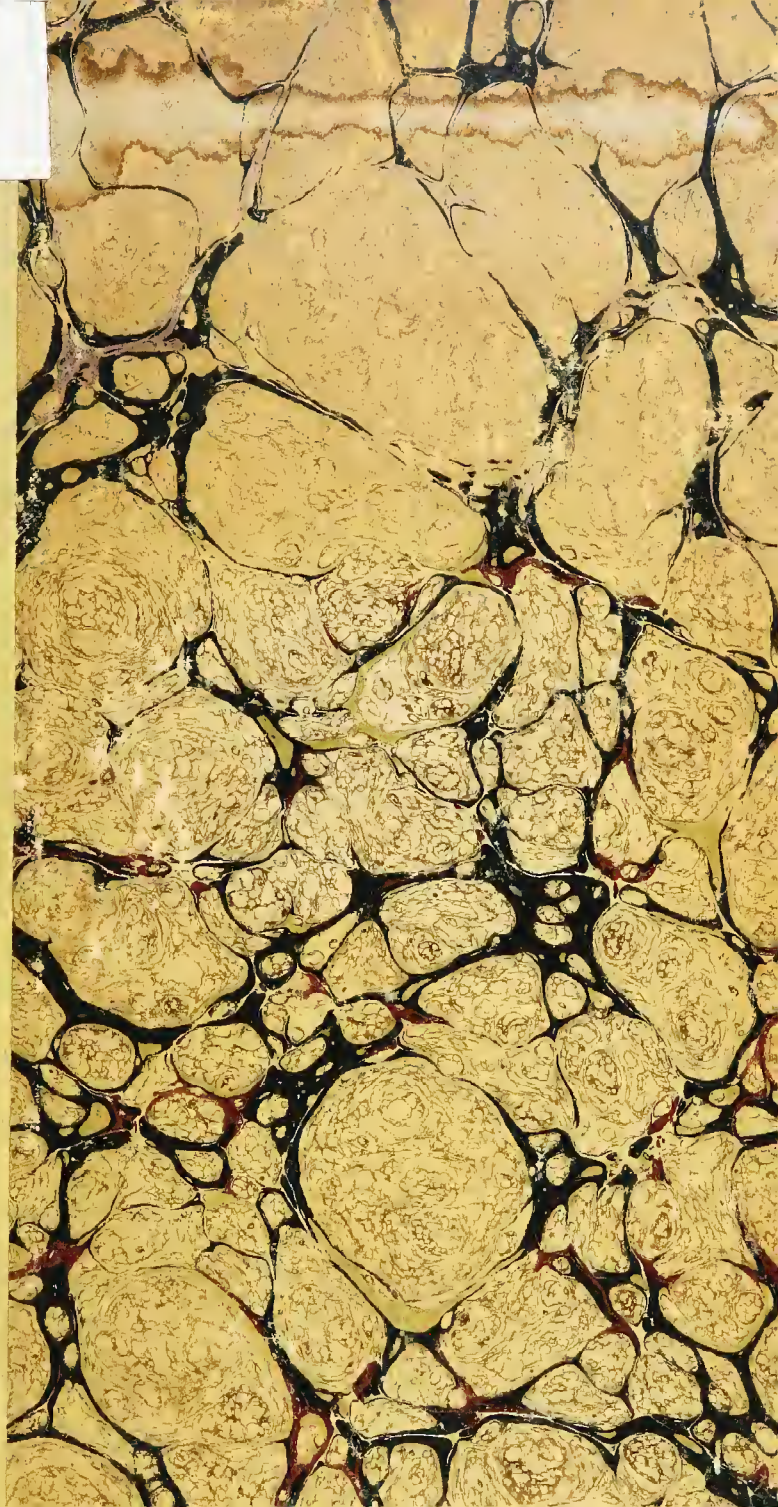
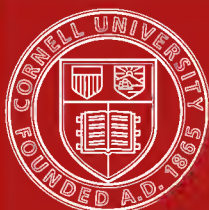


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AN EXPERIMENTAL STUDY OF SENSORY SUGGESTION

A THESIS

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF CORNELL UNIVERSITY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

BY

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Reprinted from American Journal of Psychology, Vol. XXVI,
January, 1915, pp. 99-129.

E.V.

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A. INTRODUCTION

Many definitions have been offered of the term Suggestion, and many experiments have been made in whose results the effects of suggestion have found qualitative or quantitative expression. But no one, we believe, has attempted by means of careful introspection to study the suggested consciousness itself. It is matter of common experience that suggestion may arouse, deflect or inhibit movement; it is equally clear that suggestion may change the meaning of a perception or idea by shifting its context, that is, by giving it a new associative setting. But if we ask whether or to what extent suggestion may bring about intrinsic changes in conscious contents, we receive only partial and incidental answer. A continuously rising tone, for example, is presented under the suggestion that the pitch is falling. The observer reports a drop in pitch. Has he, then, heard what he reports, or is he subject to an illusion of judgment?

In connection with sensation, especially, do we find equivocal statements and a lack of experimental study. We find statements that seem to indicate a direct sensory result of sug-

¹ From the Psychological Laboratory of Cornell University.

gestion. Baldwin, in the *Dictionary of Philosophy and Psychology*, mentions a 'sensory' suggestion; and the illustration given is that of a person who 'sees' a red light as green.² But the question remains whether, in such an instance, the observer actually sees green when red is presented; or whether he 'imagines' that he sees green; or whether, after all, the effect is motor, and he makes his reply not as the result of a sensory experience, but simply as a motor discharge which was predetermined by the suggestion. In experiments with suggestion, Scott finds 'illusions' of heat and light;³ Gilbert reports 'illusions' of weight and sight;⁴ Katz writes that a presented blue appeared dark-brown;⁵ Seashore maintains that suggested illusions are surprisingly realistic.⁶ But in no case do we find a thoroughgoing analysis and methodical control of the processes actually present in the minds of the observers. Külpe writes: "The inference is, perhaps, allowable that in certain circumstances they [centrally aroused sensations] are qualitatively similar to peripherally excited contents." But he concludes that the existing evidence from experiment is unsatisfactory; the experiments that he refers to in this connection, he thinks, "cannot be considered as wholly free from objection."⁷

It is true that hypnotism has been appealed to, in proof of the possibility of producing sensations by suggestion. The hypnotized subject appears to suffer pain, to experience feelings, pleasant or unpleasant, to realize any sensation suggested to him; indeed, Külpe affirms that to suggestion "every organic function, motor and sensory alike, is subject . . . The wildest illusions of sense and the most absurd actions are evoked with equal ease."⁸ But sensory results from hypnotized subjects, even if they were fully proved,—as they seem not to be,—could point only to the likelihood, not to the certainty, of similar results in the normal states of consciousness.

Our appeal, then, is to the laboratory and to introspection; and certain factors in the situation must especially be taken

² J. M. Baldwin and G. F. Stout, *Dictionary of Philosophy and Psychology*, ii, 1902, 619.

³ W. D. Scott, Personal Differences in Suggestibility, *Psychol. Bull.*, 7, 1910, 5 ff.

⁴ J. A. Gilbert, Mental and Physical Development of School Children, *Yale Stud.*, 2, 1894, 44.

⁵ O. Katz, Versuche über den Einfluss der "Gedächtnisfarben" auf die Wahrnehmungen des Gesichtssinnes, *Zentralb. f. Physiol.*, 20 (16), 1908, 517.

⁶ C. E. Seashore, Measurement of Illusions and Hallucinations in Normal Life, *Yale Stud.*, 3, 1895, 62 ff.

⁷ O. Külpe, *Outlines of Psychology*, 1909, 183.

⁸ *Ibid.*, 453.

into account. Since there is a natural disposition to give positive answers, it is necessary to prove that the results do not express the mere ripening of motor tendencies. It seems not at all unlikely that a suggestion may set up a definite tendency to report in a certain way, and that the appropriate situation (the critical term in a series of stimuli) is then adequate to touch off the motor response. Again, it is possible that the supposed sensation is in reality an image; the modifying effect of expectant attention must be taken into account. Abnormal conditions, such as exhaustion, morbid emotivity, etc., must, of course, be eliminated.

From this brief introduction we proceed at once to a statement of our special problem, methods and results. A history of suggestion would be blind, and a critical sifting of the outcome of previous experiments on suggestion is impossible, until we gain a positive insight into the nature of the suggested consciousness; these, then, are topics that we reserve for a future paper. Our present results are themselves hardly more than preliminary; the experimental work requires much time, and is often inconclusive; but we hope that other investigators may be attracted to the field, and that data may presently be available that shall justify a physiological theory.

B. PROBLEM OF THIS STUDY; METHOD, APPARATUS, OBSERVERS

Our general problem is that of the nature and extent of the intrinsic changes produced in consciousness by the influence of verbal suggestion. We are especially interested in sensory results, such results as are normally aroused by an adequate sensory stimulus. The experiments are, therefore, planned to favor sensory results. The questions for which we seek an answer are the following: Can verbal suggestion do the work of an adequate sensory stimulus? What percentage of judgments can be inverted, when supraliminal charges of sensory stimuli are used? How far above the limen can we get these inversions of judgment? What are the conscious processes present when such inversions are made?⁹

The experiments fall into three groups: (1) the suggestion group, (2) the control group, and (3) the liminal group.

In the first group, the observers were called upon to discriminate intensities, qualities, etc., under the guidance of a misleading suggestion; for example, a tone rose in pitch when they were told that it would fall. The first trial in every series was made with a minimal difference of stimuli, and the difference was increased in succeeding trials. *E* continued to increase the stimulus-difference until he feared

⁹ In regard to the affective processes, we merely raise the question whether the effect of suggestion is not secondary, following upon the arousal of organic sensations. We have no experimental data to offer.

that the observers would detect the deception. Suspicions on the part of the observers were unavoidable; they had to be assured again and again that *E* was giving the stimuli in accordance with his original statement. Whenever there appeared results of suggestion strikingly like the results ordinarily obtained from adequate sensory stimuli, introspections were taken, and the experience was compared with the normal: details will be given later. In the second group, the observers made the same discriminations under the regular methodical instructions. They now made them, however, with full knowledge of the suggestions employed in the first group, and with full assurance that no misleading suggestion would henceforth be used. Further, they were required to give full introspections of the fore and midperiods, with constant reference to the conscious effect of suggestion in the parallel experiments of the earlier group. The third group consisted of determinations of difference limens, by the method of limits, taken in order that the results of suggestion in the first or suggestion group might be subdivided, the trials in which the stimulus-differences were subliminal being set apart from those which gave inversions of judgment when the stimulus-differences were supraliminal. It is this latter set, in which we have what may be called supraliminal inversions of judgment, that interests us in the present paper. *E* took as the difference-limen the first difference of stimuli, correctly judged, which had two correct judgments beyond it. This is a slightly larger limen than is obtained by other forms of procedure; but the larger limen was deemed desirable, since comparison with the results of the suggestion group demanded a margin of safety. In order to make the results of the suggestion and of the liminal groups comparable, the steps in the corresponding series were kept the same. The liminal series served also to assure *E* of the normal acuity of the observers for the sense departments investigated.

Experiments 7, 8, and 9 were complete without the control group. In the remaining experiments, the control followed the suggestion group in inverse order of series. If this arrangement made the burden of memory greater for some, it greatly relieved it for other experiments; and we considered it as, on the whole, the best plan to adopt. The control for experiment 3 came immediately after the parallel suggestion experiment; for 11, there was an interval of a week; for 2 and 3, four and five weeks (3 months for one observer); for 10, two months; for 1, three months; and for 6, one, four and five months for the various observers.

Experiments were made—not all, as we shall see, with the same thoroughness or success—upon sight (quality, intensity, extent), hearing (noise intensity, tonal quality and intensity), taste (quality), smell (quality, intensity and duration), pressure (intensity), and temperature (intensity of warmth and cold). There were four experiments upon sight; three upon hearing; one upon smell; one upon taste and smell; and one each upon pressure and temperature. Most of the experiments were planned for inversions of judgment; in two cases, however,—one of the audition experiments and the smell experiment,—the attempt was made to get, by means of verbal suggestion, the process ordinarily aroused by adequate stimulus, and to get it in the absence of any adequate sensory stimulation whatever. In three cases, owing to the nature of the experiment, to lack of time, or to difficulty with apparatus, we failed to obtain liminal determinations.

For vision, colored, black and white discs were mounted on the Marbe mixer;¹⁰ recourse was also had to Whipple's apparatus for the discrimination of brightness.¹¹ For visual extent, we used Wundt's space-linen apparatus.¹² The Stern variator, Fechner pendulum and modified Lechmann acoumeter¹³ were employed for sound experiments. Two paper funnels were used in the smell experiments; small candies for taste and smell; the Wundt pressure apparatus¹⁴ for pressure, and brass cylinders for temperature. Continuous changes were possible with the Marbe mixer, the Whipple box, and the Stern variator.

In experiments of the first and second groups (with exceptions noted later), the observers were told, either that a stimulus would be given and that shortly afterwards a second would follow, or that a continuously changing stimulus would be given; they were to judge the direction of the change and, when asked, to give full introspections; the suggestion as to direction of change was made just before each trial. The suggestion always ran counter to the facts; so that if *E* said the change would be toward brighter, he changed the stimulus toward the darker. The observers were informed that the first changes would be small, and that the series would be continued until they could clearly perceive the change suggested. In the experiment on smell, the observers were told that they would be given an odor and that, as soon as they indicated their perception of it, a second odor would be given which should neutralize the first. No odors were used, and no experiment was begun until the observer reported the room free from all odors. In the experiment on taste and smell, the candies were given in pairs, the one to be eaten shortly after the other; the two differed in shape, and one was so wrapped as to appear of better grade than the other. The ingredients were the same in both cases. The suggestion lay in the appearance of the candies and in the verbal instructions; the observers were to write full introspective comparisons of the sensations of taste and smell aroused by the two kinds. In one of the audition experiments, a lead and a cotton ball were used, the sight of the falling cotton ball being the suggestion for the sound. The object of these experiments was, then, either to arouse through suggestion the process commonly aroused by an adequate stimulus, or by means of suggestion to invert judgment. The omission of several steps at the end of a series permitted the experimenter to obtain, in a few instances, very large supraliminal results, and at the same time to avoid the danger of detection, which was always present, but was especially to be feared in the longer series.

The experiments were carried on with five men in the Cornell laboratory during the greater part of two years, and later

¹⁰ K. Marbe, *Physiol. Centralb.*, 1894, No. 25, 811.

¹¹ G. M. Whipple, *A Manual of Mental and Physical Tests*, 1910, 163.

¹² W. Wundt, *Physiol. Psychologie*, iii, 1911, 466.

¹³ E. B. Titchener, *Exp. Psych.*, II., 1, 1905, 24.

¹⁴ W. Wundt, *op. cit.*, i, 1908, 674.

with five women at the University of Minnesota during one year. The men will be referred to as *A, B, C, D* and *E*; the women as *F, G, H, I* and *J*. Observers *A, B* and *C* had all had thorough training in introspection, *A* and *B* in the Cornell laboratory and *C* in the Harvard laboratory. One was an instructor in the department, one an assistant, and the third an advanced student engaged in research. *D* and *E* were respectively a fellow and a scholar in psychology. *F, G, H, I* and *J* were advanced students in psychology, one being an assistant in the department with some training in introspection; all needed further training.

A number of trials were made with other than the regular observers. These did not call for introspective reports; they were undertaken merely for comparative purposes. They showed that results similar to those obtained from the regular observers could with little difficulty be obtained from persons unconnected with the psychological laboratory and unversed in psychology. Indeed, in some instances, even more extreme results of suggestion appeared with these untrained observers.

In reporting our experiments, we shall first give the quantitative results which show the effects of suggestion in relation to the difference-limen. We shall then turn to an analytical and qualitative study of the conscious processes under the influence of suggestion.

C. QUANTITATIVE RESULTS

In calling these results 'quantitative,' we do not mean that we have measured the degree of suggestion, or that we have discovered the greatest amount of supraliminal change of stimulus that can be introduced while the judgment of the observer under the influence of suggestion is still inverted. We are only reporting, in numerical terms, the results of particular series of experiments made under particular conditions. These conditions were, in fact, distinctly unfavorable to suggestion. The instructions demanded a critical attitude; the observers were asked to make judgments in series which, so far as they knew, were part of a study of liminal differences, and which demanded their most careful attention. Seven of the ten observers reported suspicions as to the nature of the experiment, and all showed, at times, by action and tone of voice, that they thought the investigation was not what it purported to be. Finally, all such factors as fatigue, excitement, and the like, which are favorable to suggestion, were absent.

The difficulties of the experiments, the suspicions of the observers, and lack of time, made it possible for *E* to use supraliminal charges of stimuli only in 900 of the 1621 trials comprised in the first or suggestion group. In 253 of these

900 trials, the suggestion succeeded in inverting judgment. In other words, suggestion was successful in 28 per cent. of all cases in which supraliminal changes of stimuli were used. This number does not include the judgments 'doubtful' and 'equal.' Of the 254 series in the group suggestion was successful in 110, or in 43 per cent. The following Tables 1, 2 and 3, show (1) the percentage of successes of suggestion with supraliminal changes of stimuli for the various series in the suggestion group, and (2) for the individual experiments and observers, and (3) the number of steps above the difference-limen where suggestion was successful, with the number of the successful cases for every step. To repeat and emphasize, all the results noted in these Tables are results obtained with supraliminal differences of stimuli.

TABLE I

Number and percentage of series from the suggestion group containing inversions of judgment.

Part 1 According to Experiments				Part 2 According to Observers		
Expt.	Suggestion	No.	%	Observer	Series	%
1	Blue.....	17	71	A	10	25
3	Brighter.....	21	72	B	15	34
	Darker.....	20	74	C	35	42
4	Larger.....	0	0	D	3	100
	Smaller.....	2	20	E	4	100
5	Louder.....	4	80	F	14	86
	Fainter.....	4	80	G	6	35
6	Higher.....	9	45	H	3	50
	Lower.....	I	10	52
10	Heavier.....	7	100	J	10	48
	Lighter.....	0	0			
11	Warmer.....	3	36			

Total series containing inversions = 110 or 43%.

In Part 1, the first column indicates the number of the experiment; the words Blue, Brighter, etc., the suggestion used. The numbers following show first the number (no.) and secondly the percentage (%) of series in which inversions of judgment followed the use of suggestion. E. G., "17 71" means that in Experiment 1 inverted judgments were found in 17 series, or in 71% of all series in the suggestion group.

Part 2 indicates the number and percentage of series containing inversions of judgment for each observer.

TABLE II
NUMBER AND PERCENTAGE OF SUPRALIMINAL INVERSIONS

NUMBER AND PERCENTAGE OF SUPRALIMINAL INVERSIONS												
Exp.	Suggn.	A	B	C	F	G	H	I	J	Total errors	Av. %	
1	Blue.....	(3 15)	(6 75)	(37 86)	27 44	1 3	11 17	16 76	11 22	66	28	
<hr/>												
3	Brighter ...	4 44	3 15	6 25	18 75	3 15		8 37	9 50	51	37	
	Darker.....	0 0	7 33	8 20	5 50	3 16		17 71	6 23	46	32	
<hr/>												
4	Larger.....	0 0	0 0	0 0						0	0	
	Smaller....	4 36	0 0	4 23						8	21	
<hr/>												
5	Louder.....	1 25	3 14	9 69						13	51	
	Fainter	1 17	2 18	10 77						13	43	
<hr/>												
6	Higher.....	1 50	0 0	5 78						6	35	
	Lower	0 0	1 25	8 25						9	38	
<hr/>												
7	Shot.....	2 6	3 13	7 13	2 20	0 0	0 0			14	10	
<hr/>												
10	Heavier....		D	E						8	57	
			4 40	4 100								
<hr/>												
11	Warmer....	2 66	1 10	4 66						7	35	
	Colder.....	3 75	3 16	6 100						12	43	
<hr/>												
Inversions per observer.....												
Percentage " ".....												
.....												

Total errors for all observers = 253 or 28%

Numbers in the first column refer to experiments 1, 3, 4, etc. The words Blue, Brighter, etc., refer to the suggestions used. The figures in the body of the table show the number and percentage of supraliminal inversions. For example, under A are found the numbers 3 15; these mean 3 errors, which were 15% of the possible errors. The totals and average percentages do not include results for A, B and C in Exp. 1, since limens were not determined. If the limens for A, B and C are not higher than the highest limen for F, G, H, I and J in this experiment, the bracketed figures are correct.

TABLE III
NUMBER OF INVERSIONS FOR EACH SUPRALIMINAL STEP

		Experiment 1. Suggestion: "Towards Blue"																							
Degrees:		6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42					
A	DL.....			1					1																
B	DL.....		1	1	1	1	1	1																	
C	DL.....		1	1	3	3	2	2	1	2	1	2	2	1	1	1									
F	DL 5.1, m.v. 1.5.....	2	1	1	2	2	2	2	1																
G	DL 7.9, m.v. 1.2.....		2	4	2	2	2	1																	
H	DL 7.0, m.v. 1.8.....			2	2	2	2	1	1																
I	DL 10.5, m.v. 1.1.....				3	2	1	3	3	2	2														
J	DL 7.0, m.v. 1.2.....		1		1	1	2						1	2	1	1									

Experiment 3. Suggestion: "Towards Brighter"

Degrees:		4	6	8	10	12	14	16	18	20	22	24
A	LDL 9.2, m.v. 3.1.....				1	1						
B	LDL 3.7, m.v. 1.5.....	2	2	1	1	1						
C	LDL 2.4, m.v. 1.0.....	1	2	1	1	1						
F	LDL 7.6, m.v. 1.2.....			3	4	2						
G	LDL 5.8, m.v. 0.4.....				1	1	2	3	2	2		1
H	LDL.....			2	2	2	1	2	1	2	1	1
I	LDL 7.7, m.v. 1.1.....		2	2			2	1	3	2		
J	LDL 6.1, m.v. 1.9.....			1	3	1	1	1	1	1		

Experiment 3. Suggestion: "Towards Darker"

Degrees:		4	6	8	10	12	14	16	18	20	22	24
A	UDL 3.7, m.v. 1.7.....			1								
B	UDL 5.3, m.v. 1.0.....	1	1	1		1						
C	UDL 2.5, m.v. 1.2.....	2	1	3	2							
F	UDL 6.8, m.v. 1.8.....			1	1	1	2					
G	UDL 7.9, m.v. 1.4.....						1					1
H	UDL.....			2	2	2	2	2	2	2	1	
I	UDL 8.6, m.v. 1.7.....			1	1	3	3	2	4	3	1	
J	UDL 6.6, m.v. 2.2.....			1	1			2			1	

TABLE III.—Continued

Experiment 4. Suggestion: "Towards Larger"

Millimeters:

A	LDL 2.0, m.v. 0.7.....	1	2	3	4	5	6	7	8
B	LDL 2.0, m.v. 0.7.....								
C	LDL 3.3, m.v. 0.5.....								

many "equal" and "doubtful" judgments

Experiment 4. Suggestion: "Towards Smaller"

Millimeters:

A	UDL 1.9, m.v. 0.9.....	1	2	3	4	5	6	7	8
B	UDL 3.4, m.v. 0.5.....	2	1	1					
C	UDL 2.8, m.v. 1.2.....								

many "equal" and "doubtful" judgments

Experiment 5. Suggestion: "Towards Louder"

Divisions on scale:

A	LDL 1.6, m.v. 0.8.....	1	2	3	4	5	6	7	8
B	LDL 3.3, m.v. 0.8.....				1	1	1		
C	LDL 2.7, m.v. 1.8.....	2	2	2	2	2	2	2	1

Experiment 5. Suggestion: "Towards Fainter"

Divisions on scale:

A	UDL 2.6, m.v. 1.3.....	1	2	3	4	5	6	7	8
B	UDL 2.7, m.v. 1.1.....					1			
C	UDL 3.3, m.v. 1.6.....				2	2	2	2	1

Experiment 6. Suggestion: "Towards Higher"

Vibrations:

A	LDL 4.5, m.v. 0.7.....	5	6	7	8	9	10
B	LDL 6.9, m.v. 1.3.....	1					
C	LDL 5.3, m.v. 1.1.....		3		2		

Experiment 6. Suggestion: "Towards Lower"

Vibrations:

A	UDL 4.2, m.v. 1.7.....	5	6	7	8	9	10
B	UDL 5.3, m.v. 0.6.....						1
C	UDL 5.5, m.v. 1.5.....		6		2		

TABLE III.—*Concluded*

		Experiment 10. Suggestion: "Towards Heavier"					
		Grams:	6	8	10	12	14 16
D	LDL 11.0, m.v. 3.4.....						
E	LDL 10.2, m.v. 1.9.....						
		Experiment 10. Suggestion: "Towards Lighter"					
		Grams:	6	8	10	12 14 16	
D	UDL 4.8, m.v. 1.8.....		2	1		1	
E	UDL 8.4, m.v. 1.8.....		2	2			
		Experiment 11. Suggestion: "Towards Warmer"					
		Degrees:	1	2	3	4 5 6	
A	LDL 2.1, m.v. 0.7.....				1	1	
B	LDL 0.9, m.v. 0.3.....			1			
C	LDL 0.7, m.v. 0.3.....		3	3			
		Experiment 11. Suggestion: "Towards Colder"					
		Degrees:	1	2	3	4 5 6	
A	UDL 2.0, m.v. 0.5.....		1	1		1	
B	UDL 3.2, m.v. 1.8.....			1	2		
C	UDL 0.7, m.v. 0.3.....		3	3			

Table 3 shows the size of the steps, i.e., the amount of supraliminal change of stimulus, for which judgment was inverted under the influence of suggestion. Below the statement of the suggestion are given the various amounts of change of stimulus from the zero point; these are given in degrees, millimeters, etc. The first column indicates the observers; following this are given the difference-limits and their mean variations; the body of the table shows the number of cases of inverted judgment for every supraliminal step used.

D. QUALITATIVE ANALYSIS OF CONSCIOUSNESS UNDER THE INFLUENCE OF SUGGESTION

Experiment 1. Color

The Marbe Mixer was used for the introduction of yellow by continuous change into red. The change in the first exposure of the series was from 0° to 2° , in the second from 0° to 4° , and so on, the increase in yellow proceeding by steps of 2° . Each series was as long as *E* could make it without running an obvious risk of detection. A large gray cardboard served as a screen. The observers seated themselves at such a distance from the discs as made observation easiest for them; the distance was about 3m. The experiments were made with only one observer at a time, for periods of 50 minutes. Exposures were of 6 secs. duration, increased slightly for the trials where the greatest amounts of yellow were introduced, in order that the rate of introduction might be roughly the same. Instructions were as follows: "I am going to run a blue into a red on the color mixer. The change will be continuous. I want you to tell me whatever changes you notice in the color. The first changes will be very small, the changes in succeeding exposures increasing until you are sure of the change." The suggestion was generally, but not always, repeated just before each exposure: "Towards the blue," or "Still towards the blue."

Suggestion Group

Observer *A* reports as follows with the following degrees of yellow present: 10° , "Barely possible it is darker;" 20° , "Perhaps slightly darker;" 22° , "Not at all certain whether the disc is a little bluish or not now. Quite certain of change but not sure of direction of change. Is it toward blue?"; 30° , "I suspect all of a sudden that maybe there is blue in it and I've missed it before;" 36° , "Slight edge of color of rather greenish gray." *A* reported the following "prepossession": "*E* is working on suggestion, may give me no color at all, may give me wrong colors, may give me no changes, or wrong changes. May make movements intended to deceive me, also make time intervals wrong for deceit;" "Tendency to be careful;" tendency to make statements with "qualification, 'perhaps.'"

Observer *B* reports gray film, and says that it "may be due to the running in of gray." In the second of the two series *B* says, with 8° of yellow, "I guess there is a little blue in it;" and calls 6, 7, and 8 (12° , 14° , and 16°) the same as 4 (8° of yellow).

Among the reports of blue by observer *C* occur the following: 8° of yellow, "Blue ring perceived and decided it was no illusion;" 12° , "Blue ring definitely present;" 28° , "Blue ring definitely present;" 32° , "Definite blue ring not so vivid as 14 [28° of yellow] but more

than 15 [30°];" 32°, "Blue ring as faint as 15." From another series: 12° of yellow, "Obviously bluer;" 22°, "Much bluer than 1;" 28°, "Color has blue in it." After this series C was asked to indicate with discs how much blue he thought had been used, and he set them with 35° of blue exposed.

Observer *F* gave the following reports: with 18° of yellow, "Slightly more blue than 5 and 6;" 10°, "Noticeably more blue;" 12°, "Same as 5; perception of blue was less marked in appearance but lasted for a longer time;" 28°, "Perception of red changed distinctly towards blue; . . . surprised to see the blue so distinctly. . . . The blue present was very definite;" 34°, "Blue was very distinct, so much so that the color was quite blue;" 36°, "Blue lasted longer than in 15;" 42°, "The red seemed to be slightly darker, with a gray more than a blue."

Observer *G* was frankly suspicious after a few trials; her brother, she said, had 'fooled' her so often that she was generally on her guard. Some results were obtained: 8° of yellow, "Doubtful; first judgment 'darker,' second judgment 'lighter';" 14°, "Two judgments; one that the hue grew darker; second judgment 'no change';" 16°, "Changes from darker to lighter and darker again." *G* reported 'no change' or 'doubtful' for changes of 8°, 10°, 12°, 16°, 22°, 24°, 26°, 28° and 30°. At 28° she said: "Might have been a change towards blue."

Observer *H* reported the following: 10° of yellow, "Very faint blotches of slightly darker hue;" 10°, "Darker hue seemed to be in narrow bands;" 10°, "Slightly darker;" 10°, "Darker hued;" 18°, "A bluish-pink tinge in a filmy form, seeming to stand out from the background." Many reports of "No change" were made with the yellow shown at 10° to 40°.

In a few cases, *E* reversed the direction of stimulus-change at the end of a series, in order to avert a suspicion which had become evident in the observer's voice, manner or replies. In one series with *H* the results show that within a few trials a large increase of yellow and a large decrease of yellow can both be judged as changes in the same direction. In another series *H* reported "No change" when the stimulus-change was an increase of 34° and 40° yellow (14 and 17 steps beyond the DL).

Observer *I* frequently reported blue: 14° of yellow, "Medium blue discs . . . blue shadows;" 16°, "Single grayish blue disc rises over red from below and remains, not quite covering it;" 20°, "Red seems to blend with blue-gray;" 14°, "Bluish shadow appeared about a second after disc was exposed, . . . moved back and forth;" 18°, "Distinctly a violet-blue film over surface;" 20°, "Change to a purplish red with a great deal of gray in it, and this darker red, not a purple but a purplish red, . . . seemed to fuse this time except at edges and right in center of disc;" 22°, "Yes, grayish blue, . . . a little denser and a little darker and more mixed with the red than it had been before;" 22°, "Change to blue. It was unquestionably blue. . . . The blue was like a veil over the red, but it was unquestionably blue. It did not fuse with the red." Other reports of like nature were made.

Observer *J* reported the following: 10° of yellow, "Part . . . seemed a little darker . . .;" 28°, "Columns of shadow . . .;" 22°, "Columns of darkness;" 14°, "the orange-red changed to a brownish-red;" 30°, "Perception of a bluish-lavender, . . . perception of a more brownish-red background; the bluish-

lavender gradually changed to a more distinctly dark blue perception. The dark blue was not very definite, although I was certain that it was blue and no other color;" 32°, "A bluish-lavender appeared, 36°. . . I am certain that the perception was that of bluish-lavender;" 36°, "No change."

Further results of the same kind might be quoted from the reports of all observers. Needless to say, pauses were often made in the longer series, to avoid fatigue and eye-strain; the observers were continually cautioned beforehand not to make an observation unless entirely free from after-images; and the experimenter frequently enquired, during an experiment, about the presence of after-images.

Control Group

Introspections were secured from observers *F*, *G*, *H*, *I* and *J*. We can give only brief summaries.

Observer *F* rarely reports imaginal processes; judgment comes "following directly the perception of the blue," "with the perception of blue as the clearest thing in consciousness." Once she reports a "readiness to say blue." There is apparently no change of attitude from the one group to the other; and assurance is no greater in the control than in the suggestion series.

Observer *G* expresses her judgments in "Yes," or "Positive," but a good deal of doubt is still reported. There is sometimes much imagery, expectant and memorial, and sometimes again this imagery precedes judgment; but ordinarily the judgment is reported as direct. There is change of attitude, but no marked increase of assurance.

Observer *H* has a good deal of imagery, and sometimes reports verbal processes, though both alike are usually "very dim," "merely an undercurrent of little importance." In recalling earlier series *H* says: "The changes to blue . . . in the suggestion series were clear perceptions, though not of so great change. . . . They were perceptions from the fact that what I saw was different from what I expected to see, i. e., a dark sector on red."

The shift from a suggestion series to a control series was made with observer *I* during one of the hour-periods. It was not, however, until 18° of blue were introduced that she said "Blue was not so blue in the other series." Her introspections show two kinds of judgment: in the one, there were many imaginal processes, in the other no imaginal processes at all were reported, and the judgment was touched off directly by the stimulus. Her assurance is the same in both groups. She used, in the first group, such words as "unquestionably," "distinctly," "clearly," in referring to changes toward blue, and showed no trace of doubt in tone of voice or in word. "As to the earlier group there was no question of the clearness of change and my sureness of the change. It was distinct, and a change, so far as I can tell, actually of sensation . . . ; the changes had all the characteristics of sensory experiences, and, at the time, I should not have thought of calling them anything else than sensory."

J's judgments occasionally come with a "yes," and kinaesthetic-verbal elements are characteristic of her reports. In comparing the two groups she says: "No more clear or distinct than in the cases where I was sure of the blue;" "Experiences exactly like those in other experiments; things seem to go just the same."

Summary of Results from Experiment 1

(1) The records of the suggestion group show results that are very similar to (in some cases indistinguishable from) results reported in the control group. There are a few of these for A, B and G; many for C, F, H, I and J. Even where the observers think that they have found specific differences in the experiences of the two groups (as happened in certain instances with I and J), reference to the record shows that exactly the same things are reported in both sets of experiments.

(2) The assurance of F, H, I and J is the same for both groups; that of G is not markedly different.

(3) The introspections show (a) judgments with a good deal of imagery; (b) judgments which seem to indicate the touching-off of a tendency to agree with the suggestion, to say "Yes" or the like; and (c) direct judgments without imagery and with no apparent intervention of the motor impulse to accept the suggestion; here the observation itself appears to be modified. Judgments of the third or sensory type were largely predominant in this experiment with observers F and H, and were in the majority with G and I.

(4) The reversal of direction of large stimulus-changes, for two observers, is in the one case barely noticed and in the other, is accepted as a continuation of the series. Definitely supraliminal changes in opposite directions are, by both observers, judged as changes in the same direction.

Experiment 2. Colorless Discs

This experiment, made with black and white discs on the Marbe mixer, seemed fatally to arouse (or confirm) the suspicions of the observers. Hence E took only one series with A and five with C. In the series with A, the suggestion was "Towards brighter." With 6°, 8°, and 10° decrease of white A reported no change; with 12° he said: "Might have increased that time; can't be sure at all." The obvious suspicion of A made it necessary to discontinue the experiment. Observer C gave the judgment "equal," under the same suggestion, with decreases of 8° and 10°.

Experiment 3. Colorless Light

The Whipple box, set up in the dark room, was arranged to show light only in one window. The bar connected with the reflector was lengthened, so that small changes of stimulus were possible. Steps of 2° on either side of the neutral position of the reflector were used. The instructions were: "I shall give you a continuously changing light, and I want you to report as soon as you notice the change in brightness. Please indicate also the direction of the change. The change in the first trial will be very small, and will be increased in each succeeding trial until you notice the change." The suggestion

was repeated at the beginning of every series, and generally before every trial: "Towards the brighter," or "Towards the darker." Fifteen minutes were allowed for dark adaptation, and care was taken throughout the experiments to avoid after-images. The exposure was of 6 secs. duration, and was slightly increased for the larger changes.

Suggestion Group

Observer *A*, with the suggestion, "Towards brighter" and the stimulus-change actually from 0° to 12° darker, reports: "Believe it did get lighter right near end." Again, with 12° change towards darker: "A wee mite lighter and then a wee mite darker, very small but *very definite*." With 6° and 8° darker *A* reported "lighter, doubtful," and with 10° darker, "Wee mite lighter." It is to be noted that, just before this series, *A* had asked *E* to give a few practice trials in each direction, and that *E* had granted the request.

B's reports frequently raise the question whether the change is as suggested. With 8° , 10° and 12° change in both directions, "no change" and "doubtful" are reported. *B* was evidently suspicious; and in the last series, where the suggestion was "Towards darker," *E* reversed his direction. The change was from 8° in the one direction to 12° in the opposite direction, a change of 20° ; it was, however, accepted simply as a continuation of the series.

Observer *C* gives many "doubtful" and "no change" judgments, even where the stimulus-changes are clearly supraliminal. But he also gives inversions of judgment with full assurance. With the stimuli 8° and 10° lighter he reports "darker" emphatically. Again, with the stimulus 12° darker he says: "Brighter, sure." Once, when the stimulus-change was 12° darker, he reports: "Three periodic changes constituting increase of brightness, each followed by a darkening. That actually occurred subjectively."

Observer *F*, with suggestion "Towards brighter" and stimulus-change 20° darker, says: "Got brighter, distinctly brighter, then darker. . . . Change from lighter to darker was very slight." In another series, with suggestion "Towards brighter" and stimuli 10° , 12° , 14° , 16° , 18° and 20° darker, all judgments are "brighter." With 18° , e. g., *F* says: "There was a change from darker to brighter, quite distinct, short duration;" with 20° : "Much brighter than last, grew brighter for a time, and then a dark streak through center." Just before the second series of this experiment *F* asked: "Isn't there a good deal of suggestion here?" and added, "My natural tendency is to do the opposite." Immediately afterwards, with the suggestion "Towards darker" and actual changes of 8° , 12° and 14° towards the lighter, *F* reported "darker," and said in every case that she was sure of the change.

Observer *G* was still on her guard. When the judgments were inverted, she was generally doubtful. With a stimulus-change 22° brighter, she reports: "That seemed darker; quite surprised at judgment; not very sure of it; seemed to get lighter at end; then more sure of judgment after I looked at it again; seemed an evident change." In another series, with a stimulus-change 18° brighter, she says: "Seemed as though getting a little darker; not sure; two or three judgments; first that it was darker; then that it was not darker; then that it was darker. Think it was imagination more than anything else."

Observer *H* gets definite results with full assurance. With suggestion "Towards darker" and stimulus-changes of 10°, 12°, 14°, 16°, 18°, 20° and 22° towards lighter, all in one series, *H* reports that the changes are towards darker. In another series, "Brighter" is reported when the stimulus-changes are 6°, 8°, 10°, 12°, 14°, 16° (18°, "no change"), 20°, 22°, 24° and 26° darker.

The reports of *I* also show definite results. Characteristic is the following: 18° darker, "Change half way through; seemed to light up and a difference in depth; seemed to have third dimension, depth, as if I could put my finger into it; then stayed at this brighter intensity the rest of the time." Once when the stimulus-change is 18° brighter *I* reports changes in both directions, but says she is surer of the change towards darker. It is to be noted that this observer often reports twofold changes of this kind, and that she is always surer of the suggested changes than of those due to the actual change of stimulus. *I* even uses the word "brilliant" in describing a change with the stimulus 20° darker.

Observer *J*, with suggestion "Towards darker" and stimulus-change 10° lighter, reports: "Noticeable change first towards darker; constant for a while; then slightly brighter; change towards darker came suddenly, was distinct but only a slight change; change towards lighter was not quite as distinct; I was not as sure of that." With a change of 22° towards lighter she reports: "Distinctly towards darker; very distinctly noticeable; greater change than in any of the other experiments."

Control Group

Observer *A* reports an "agreement" which he "seems to have ahead of time," and he often replies with a "Yes;" "Judgment shot itself off, 'Yes.'" Sometimes *A* also reports a good deal of imagery. He is, however, an observer of a rather extremely 'objective' type, with a persistent tendency to hold fast to the stimulus and to accept the sense-impression as it comes. His judgments, so far as we can tell, are nearly always of the sensory type. There seems to be no greater assurance in this group than in the suggestion group.

Observer *B* often replies by "yes," and reports much kinaesthesia (eye-strain, tendency to nod head, etc.). Once he reports: "A vague memory of previous experiments when I had to be on my guard." His attitude and assurance were changed in the control group.

Observer *C* reports changes no greater or more definite in this than in the suggestion group. In fact we find an emphasis placed on a few, at least, of the inverted judgments which we do not find in the control group. *C* gives many imaginal and mixed judgments; but the sensory are the more numerous.

Observer *F* reports judgments with and without imagery. When asked to compare the experiences of this group with those of the suggestion group she said: "At the time they seemed to be actually sensations. There did not seem to be anything imaginal about them. I should probably have declared under oath that there was a change 'towards brighter' or whatever you suggested." After another trial she said: "Same effect though not as distinct as last time. This was about the same as in the first group. I don't think that if I had the two side by side I could have told any difference, unless this latter might be a little clearer and I can't be sure of that. They were very much alike, I am sure of that." And again: "In trying to decide whether my experiences were sensory or imaginal, there seemed to be both sensations and images, but I seemed to get things I did not expect

and had not imagined. Sometimes the light seemed to be brighter, so much so that I felt surprised. . . . Some of the results were different from that imagined, i. e., expected. It seems to me now that suggestion affected both imagery and sensations, but I can't tell which was affected most."

Observer *G* expresses much doubt in this group, but less than in the suggestion group. With 20° change towards brighter she is doubtful, and with 24° she says: "Guess that was brighter, not sure." After an observation with 20° darker, she remarks: "This seemed about the same as results in the suggestion group. I don't seem to notice any difference between this last experiment and the suggested experiences." Later, in support of her statement that her former judgments were due to 'imagination,' she says: "In sensation I see the change towards darker as a cloud. If it were imagination, it would be confined more to the window itself. When I shut my eyes I can get a clear-cut image of the window itself." But several reports in the suggestion-group refer to just this "cloud"-effect, which the observer maintains would make the experience sensory.

Observer *H* can find no difference in the experiences of the two groups. "Can't now pick out any differences. Changes seemed definite then and they are definite now." "The changes in the first group seemed just as much out in front of me; these in the second group no more clear or definite. . . . I think the change was sensory because the change came differently than I expected it would; I had images of what I expected, and what I saw was contradictory to the images." It should be noted that in this case the control group followed the suggestion group at an interval of only a few days.

Observer *I* agrees with *H*. "At the time I looked at them [the exposures of the first group] they were perfectly real; they looked just like a moving picture or panorama that moved in front of me; it was different from imagination and I did not doubt its objectivity." "They seemed like sensory experiences in that they seemed to be presented to the eye with visible changes. . . . There was also an . . . idea that the changes were not quite what I expected them to be; it was a little feeling of dissatisfaction, although I had no definite images of what I should get. . . . If you had said to me that it was just my imagination, I should have taken exception to it, because I really saw something there."

Observer *J* has slightly less assurance here than she had in the suggestion group. She reports that there is no difference that she can name between the experiences of the suggestion and of the control groups; "The effect of suggestion in earlier group was certainly, I think, on the sensations."

Summary of Results from Experiment 3

(1) Again, similar (and in part indistinguishable) results are obtained from the experiments of the two groups.

(2) The assurance of *A*, *C*, *F*, *H*, *I*, and *J* is approximately the same in both groups. *I* expresses greater confidence in the suggested than in the actual change, when on certain occasions she reports change in both directions.

(3) The introspections again show three types of judgment, the imaginal, the motor, and the direct sensory judgment. The sensory type is the most frequent in this experiment: the judgments of ob-

servers *A*, *H*, *I* and *J* are predominantly direct; those of *C*, *F* and *G* are sensory or imaginal or mixed; those of *B* are largely motor.

(4) *A* finds a "very definite" change (judgment being inverted) immediately after *E* has given, at *A*'s request, special practice trials with knowledge. *B*, in the suggestion group, accepts a very large change of direction as simply a continuation of the series.

Experiment 4. Visual Extent

The Wundt apparatus was arranged to show a white rectangle, 14 by 60 mm., upon a black background. The rectangle could be lengthened or shortened at will; the unit of change was 1 mm. The observer saw the standard strip for 1 sec.; then came a pause of 5 secs.; and then the comparison strip for 1 sec. The instructions were: "I shall expose a rectangle, first, at the standard size; then I shall expose it at a length either greater or less than the standard. You are to note any change in length, and to indicate whether the second rectangle is longer or shorter than the standard. The change in the first pair will be very small, and will be increased in succeeding pairs till you notice the change." The suggestion was repeated before every trial: "Towards the longer," or "Towards the shorter." A head-rest brought the eyes of the observer 90 cm. from the frame. A gray card, placed just before the stimulus, aided fixation and also helped to eliminate after-images. Great care was taken to rule out secondary criteria. *A*, *B* and *C* took part in the experiment.

Suggestion Group

Observer *A* gave comparatively few inversions. With the variable 4 mm. larger, he reported, with no doubt at all, "shorter." With a change of 5 mm. he said "larger, doubtful;" with 6 mm. he was sure of "longer." In another trial a decrease of 3 mm. was judged "longer" with no doubt. There were many "doubtful" and "equal" judgments. *A* declared his suspicion of the use of suggestion almost at the beginning of the experiment, and said: "I seem to be more suggestible in this experiment than in the others."

Observer *B* showed in tone of voice and in manner that he questioned the nature of the experiment; and failure in four series led *E* to discontinue it. There were no inversions, but the judgments were mostly "equal" and "doubtful."

Observer *C* gave no inversions when the change was actually towards the smaller. There were, however, many "equal" and "doubtful" judgments with changes as great as 5 and 6 mm. *C* reports that, when *E* says the change will be in one direction, "the suggestion" seems to make it just the opposite.

Control Group

Observer *A* finds the "readiness" or "agreement" that he has reported before. The typical introspection shows little or no imagery.

He says, e. g., "Attention strong on second stimulus; 'shorter' came out immediately upon clear visual and kinaesthetic perception of the stimulus."

Observer *B* gives his judgment characteristically by "yes." "A peculiar auditory after-image immediately succeeded *E*'s voice, a sort of echo accompanied by verbal idea 'yes, smaller.' I not only say to myself 'smaller' but say to myself 'yes, smaller.' Sometimes I think it quite irrelevant whether I tell you my judgment or not. The fact that I say 'yes' to myself seems to show the working of the suggestion." "Strong repetition of instructions seemed to constitute the suggested consciousness. When I actually do see the second stimulus it is surprisingly more different than I expect. That surprise is mainly kinaesthetic and organic, partially in verbal comment as if setting of mouth to say 'why?'"

Despite the verbal set, *B* reports that there is no tendency to give a judgment before the second stimulus is perceived.

Observer *C* reports a good deal of imagery which appears to be largely responsible for the 'equals' and 'doubtfuls' of the suggestion group. "The perception of the white is not constant; the apperceptive process undergoes development and changes."

Results of Experiment 4

(1) This experiment was not successful. Only in one or two cases do we find inverted judgments given with an assurance as great as (or greater than) that of the correct judgments.

(2) The types of judgment—motor, imaginal, sensory and mixed—are fairly evenly represented. *A* and *B* tend here toward the motor, *C* is definitely of the imaginal type.

Experiment 5. Noise Intensity

The point marked 45 on the graduated arc of the Fechner pendulum was chosen as that from which to give the standard stimulus. The steps used for the variable were the divisions of the scale. The observers were instructed as in the former series. The interval between standard and variable was 8 sec. The suggestion was given before every trial; "Towards the louder," or "Towards the fainter." *A*, *B* and *C* took part in the experiment.

Suggestion Group

Observer *A* stated near the beginning of this experiment that he gave himself the counter-suggestion of equality of the stimuli; and *E* did not venture to give many supraliminal changes. With the suggestion "Towards louder" *A* reported: 38, "Weaker, very doubtful;" 42, "weaker, doubtful, just a trifle weaker;" 41, "equal or a trifle louder; second seemed to have more volume;" 40, "equal or a trifle louder." With the suggestion "Towards fainter" *A* responded: 47, "equal, doubtful;" 49, "louder, doubtful;" 50, "trifle louder;" 51, "weaker, not very much weaker, but my judgment was fairly sure." A reversal of stimulus-change, made at the end of one series, was accepted without comment, as if a continuation of the series. All of these changes were supraliminal.

Observer *B* reported: "Sometimes it seems to go opposite to what you say it will. I sometimes say 'doubtful' and wait till another step." With the suggestion "Towards louder" *B* replied: 42, "doubtful, a difference, not very sure whether louder or not;" 40, "equal;" 38, "equal;" 37, "certainly sounds less;" 36, "less." *E* then gave a large supraliminal change in the opposite direction, and *B* merely said "more," accepting the trial as a continuation of the series. With the suggestion "Towards fainter" *B* answers: 51, "about equal;" 50, "equal;" another 50, "That was less; that was quite surprisingly less;" 52, "That wasn't less, equal if anything;" 53, "equal;" 55, "equal;" and in this series it is only at 56 that *B* says "louder." *E* then altered his direction, and gave 40. *B* said: "Less, not as sure about it as other, but no doubt." This change, too, was accepted as a continuation of the series; although, just before it was begun, some practice trials had been made in both directions.

Observer *C* reports suspicion of the experiment. Yet with the suggestion "Towards louder" he responds: 42, "louder, sure judgment;" 36, "very slightly louder or equal;" 41, "louder;" 39, "louder" (*C* adds here that he could "judge confidently; my attention has been good, hence the confident tone of voice"); 38, "louder," again with confident voice. With the suggestion "Towards fainter," *C* gives at 51, "fainter, fairly confident."

Control group

Observer *A* gives his judgments nearly always by "yes" or "plainly" or some like word. In nearly every case the analysis of judgment shows the intervention of anticipatory auditory images. The situation differs from the preceding, in that now there is no self-suggestion of the equality of the two stimuli.

Observer *B* often refers to the automatic release of the response. "The word 'yes' was almost forced upon me, as if I could not say anything else."

Observer *C* also reports several cases in which the judgment was touched off automatically. He has, however, a good deal of imagery, visual and kinaesthetic, and once mentions an anticipatory image of sound.

Results of Experiment 5

(1) All three observers give inverted judgments with as much assurance as the judgments of the control group.

(2) Reversal of direction of the stimulus-change is accepted by *A* and *B* without surprise or comment. With both observers, the changes involved were large.

(3) The judgments in this experiment were characteristically of the motor type. With *B* these motor judgments are largely preponderant; and with *A* (who inclines strongly to the sensory) and *C* (who inclines to the imaginal) they are in the majority. *A* reports the almost constant appearance of auditory images.

Experiment 6. Pitch

The standard stimulus was a tone of 870 v. d. from the Stern variator; the unit of change, up and down, was 2 v. d. The duration of the stimulus was 6 sec., increased slightly for the largest changes. The observers sat about 5 m. from the apparatus. The instructions

were: "I am going to give you a continuously changing tone, and I want you to report as soon as you notice the change in pitch. Please indicate also the direction of the change. The change in the first trial will be very small, and will be increased in each succeeding trial until you notice the change." The suggestion was repeated before each trial: "Towards the higher," or "Towards the lower." Observers *A*, *B* and *C* took part in the experiment.

Suggestion Group

Observer *A* was so suspicious of the experiment that but few series could be taken. There was, however, one inversion of judgment with supraliminal stimulation.

Observer *B* was also very suspicious, and the series were therefore curtailed. There were, however, clear supraliminal inversions: e. g., with the suggestion "Towards higher" and the stimulus-change to 860 v. d., *B* judged "higher."

Observer *C* declared, before the end of this experiment, that he thought the experiments were on suggestion. *E* told him emphatically that he was making a study of limens, but that he did not wish to explain further. The few results obtained are the more striking as *E* gave *C* on request a number of trials for practice, both up and down, at the beginning of the series. Most of the inversions occurred at 6 v. d.; but once, with the change of 8 v. d. higher, *C* replied "down" with no comment; and once, with the change of 8 v. d. lower, he replied "higher" with no comment.

Control Group

Observer *A* finds nothing new in introspection except the prevalence of tonal imagery.

Observer *B* reports characteristically by "yes" or some like word. Once he says: "My readiness to make the judgment was present before the tone came."

Observer *C* still reports much imagery.

Results of Experiment 6

(1) This experiment was not successful. A few inverted judgments, especially with observer *C*, show an assurance equal to that of the control group; but the results are very scanty.

(2) *B* gives judgments chiefly of the motor, *C* of the imaginal or mixed type. *A*, as in the preceding experiments, is of the sensory type.

Experiment 7. Noise

Series of 10 stimuli were given by the modified acoumeter; 8 with the larger lead ball commonly used; 2 (at varying places in the series) with a cotton ball made compact by a few stitches of thread and blackened with ink. Preliminary observations were taken with the lead ball, in order that this sound might, in the experiments proper, be made definitely supraliminal. The observers were seated

at a distance of 3.5 to 4.5 m., from which they could easily see the ball drop. The intervals between trials were of 8 sec. duration. The instructions were: "I want to make a few preliminary trials to find the limen roughly and see if I can make use of the experiment. Tell me whether or not you hear the sound from the ball dropping. You are to watch the ball, and to report after you see it drop." The suggestion lay in the fall of the cotton ball. Observers *A*, *B*, *C*, *G*, *I* and *J* took part in the experiment.

Suggestion Group

Observer *A* expressed surprise that he saw the ball drop but did not hear it. Once he "heard it hit the side after it dropped;" and once he replied confidently with "Yes." A little later he said he believed *E* was using two balls and trying to 'fool' him.

Observer *B* reported hearing the cotton ball three times; once he gave the judgment in a "yes" that indicated conviction. During one series he remarked: "When I don't hear it I think it is a lapse of attention; it takes about all the attention you have."

Observer *C* often reported that he heard the ball drop. His reports were given with full assurance, notwithstanding the fact that he several times failed to hear the ball and complained of lapses of attention.

Observer *G* reported 'hearing' the ball drop once; *I*, once; and *J* not at all. Failure was due, in part at least, to suspicions on the part of the observers. *G* expressed some doubt about her judgment, although she called the experience a "perception of sound;" and her final judgment was "positive."

Control Group

No introspections were taken from *G* and *J*. The two following reports from *I* are typical.

Lead ball used: "Visual perception of falling shot; fell in straight line. Auditory perception: sound of falling shot; quality clear; auditory image of ticking of clock. Duration very short; sound faint and far away."

Cotton ball used: "Visual perception of falling shot. Seemed to fall faster than before. Auditory perception, sound of shot falling, clear; duration longer than before. Sound quite loud and unmistakable; visual and auditory image of dried pea falling on glass counter."

Results of Experiment 7

We have found cases—a considerable number with one observer—in which a cotton ball is 'heard' to drop just after a lead ball has given a definitely supraliminal stimulus. The judgments are passed with assurance; and they are not corrected later, although the true stimulus is immediately repeated. There is nothing to show that the suggested experience could be distinguished from that aroused by adequate stimulus.

Experiment 8. Smell

Two paper funnels projected from a small closet in which *E* sat during this experiment. *E* often made various noises to suggest the presence of apparatus; no odors were used. The observer sat about 3 m. away, directly in front of the funnels. The instructions were: "I shall give you either a pleasant or an unpleasant odor, which will come from one of the funnels, and I want you to tell me as soon as you notice it. I shall keep the time with a stop-watch. As soon as you report the first odor, I shall give you another which will neutralize the first, and I want you to tell me as soon as the first odor has disappeared." The suggestion was made before each trial: "I shall now give you a pleasant [or unpleasant] odor." The observer was asked to give as full an introspection as possible after each successful trial. Observers *D* and *E* took part in the experiment.

Observer *D*; suggestion of "unpleasant odor." Duration, 31 sec.: "Got just one whiff of unpleasant odor; it smelled like hydrogen disulfid. I had a decidedly unpleasant odor." Duration, 106 sec.: "Before getting the smell there was a watering of the eyes, then rapidly followed a tickling in the nose and in about the same interval the smell came. I tried hard to get smell all through period; concentrated attention to get it. It does not seem to stay or grow more intense but comes and goes. The odor was very clear; I do not believe it could be any clearer. It burst out quickly; got no after-image. My eyes smart a little now." Duration, 97 sec.: "Same characteristic tightening in forehead and sensations in throat. The smell is the same I have spoken of only more intense. It was disagreeable and I smelled it a long time before it was disagreeable; not very clear at any time, but got the odor definitely; what I reported I got." Only two positive results came with the suggestion of "pleasant odor." Once *D* said: "I can't really smell it, but think there is a smell there because of the change in blood pressure;" and again: "Slight odor; no pleasantness or unpleasantness."

Observer *E*: Suggestion of "unpleasant odor."—Duration, 96 sec.: "It was rather irritating; seemed to irritate lining of nose and throat; something like ammonia. It wasn't intense enough to be really unpleasant. I could only get it by keeping my attention on it. Fairly clear." Duration, 97 sec.: "The unpleasant odor seemed fainter than before, and I was rather conscious of smelling something than of a particular smell. It was irritating. It was not clear."—Suggestion of "pleasant odor." Duration, 56 sec.: "Very faint and of a pleasant soothing nature. I got it as an odor only, that is there was no irritating effect, and I got it in the fore part of my nose and it was fairly clear." Duration, 134 sec.: "It was pleasant, of a soothing, sweet nature; I got it in the fore part of my nose. It was rather clear and lasted about three minutes."

Results of Experiment 8

- (1) The reports of odors are given with full assurance.
- (2) Although the reports mention various modes of tactual experience, yet they distinguish these from the experience of smell proper.

Experiment 9. Taste and Smell

Specially prepared small candies were used. Half of them were wrapped at the time of the experiment in tin foil; these were also of different shape from the unwrapped. All were made at the same time, and were of the same material and the same size. The foil-covered candies were called A, the others B. The observer tasted A (or B) for 15 sec.; then rinsed the mouth (about 30 sec.); then tested B (or A) for 15 sec.; and then gave his judgment. The instructions were: "I am going to give you two stimuli, and I want you to make a careful comparison between the two as regards gustatory and olfactory sensations." A, B and C took part in the experiment. Each observer made 10 comparisons. Differences were reported as follows:

Observer A: A sweeter 6; B sweeter 2; A more bitter 4; B more bitter 1; A more olfactory 4; B more olfactory 1; A smoother 2.

Observer B: A sweeter 1; B sweeter 6; A more bitter 4; B more bitter 1; A more sticky 6.

Observer C: A sweeter 2; B sweeter 3; A more bitter 4; A more olfactory 2.

The following are typical introspections. Observer A: "In A the sweet tasted first quite intense, then bitter, with smell quite intense. Intensive changes or alternations. A also is harder than B. In B the sweet is less intense than in A. Bitter is a long time coming as also is the smell, neither so strong as in A. No such alternation of large-small intensity as in A." Observer B: "A called forth first tactual and vague kinaesthetic sensations, sweet, not strong, some slight cold sensations in middle of tongue. Finally a bitter almond taste, not quite as strong as the sweet. Touch outlasted them all. B was very much sweeter, sticky, and the last burnt smell came only immediately before rinsing the mouth. The kinaesthetic sensations from chewing were somewhat clearer than in A, but not more intense." Observer C: "B held at the tip of tongue. At first a very bitter sensation there. Then the stimulus was broken up. Now sweet sensations for a considerable period mild, then becoming very strong with a very faint admixture of bitter sensations. A held at tip of tongue. Stronger and more widely distributed bitter sensations than with B. Then the stimulus was broken up. Now sweet sensations for a time mild, then becoming seemingly as strong as those of B. But, perhaps, not maintaining this high intensity for so long a time. Admixture of stronger bitter sensations than with A."

At the close of the experiments the observers were asked if they had noticed any constant differences between A and B. Observer A decided that A was generally smoother, softer and sweeter; quite often more bitter and having a stronger smell than B; taste and smell sensa-

tions rise more quickly in A than in B. (His reports show that A is generally reported as sweeter, more bitter and more olfactory than B; B also is reported as harder than A, and A as smoother than B.)

Observer B decided that B was sweeter and more sticky than A. (This agrees with the reports, which show that B was sweeter and more sticky than A; B is also reported, however, as more bitter.)

Observer C decided that A and B were the same, except that A was the more bitter. (This excess of bitter is the difference most prominent in his reports.)

Results of Experiment 9

(1) The reports of difference are given with full assurance, and differences are often reported as large, although the observers, especially A, had their suspicions that the stimuli were identical.

(2) The judgments are all (except in one instance with observer C) of the direct sensory type.

Experiment 10. Pressure

Stimuli were applied to the back of the hand by the ivory button of the Wundt apparatus; 50 gr. was the standard; change was made by steps of 2 gr. Application was for 1 sec., and the interval was 5 sec. Care was taken to prevent fatigue. Instructions were as in other experiments. The suggestion was repeated before each trial: "Towards the lighter," or "Towards the heavier." Observers D and E took part in the experiment.

Suggestion Group

D gives many "equal" judgments. With suggestion "Towards heavier," and lighter stimuli 6 (once), 12 (once), and 8 (several times), he says "heavier." Twice E reversed the direction of stimulus-change, to avoid suspicion: in the one case, in which the second stimulus was lighter, D said "heavier" at 6, and "equal" at 8 to 16; change was then made from 16 lighter to 8 heavier, and D accepted the stimulus as a continuation of the series, and still judged "equal."—With suggestion "Towards lighter" there were no inversions, but many judgments of "equal."

Observer E reported "heavier" when the stimulus was 8 lighter (twice) and 10 lighter (twice). There were no inversions with the suggestion "Towards lighter," though there were several "equal" judgments.

Control Group

Observer D reports a great deal of imagery, visual, verbal-auditory, and anticipatory tactual. Thus: "Sensation from first stimulus; images left consciousness entirely, tactual sensation very clear. Then tactual image came, and verbal-auditory image of word 'strong.'"

Observer E also describes much imagery, chiefly visual.

Results of Experiment 10

This experiment was inconclusive. Several inversions, however, occur with full assurance. Reversal of direction of stimulus-change was possible without comment from the observer. Judgments were predominantly of the imaginal type.

Practice experiments made with observer *F* and another whom we shall call *K* (a man taking advanced work in psychology) led to results that may be mentioned here. Discrete stimuli were given with a small spring pressure-apparatus, and no misleading suggestion was employed. The observers were told only that two pressures would be given, the second heavier than the first, and were asked to make as full introspections as possible.

Observer *F* reported: "First noticed the instrument before it touched my hand; then felt pressure and tried to carry it over in memory; held breath till second came. Second more intense; slight pain; seemed to feel it coming by degrees till instrument touched hand." *E* asked *F* to say more about the fore-period, before the stimulus was applied. "First feeling was less intense. It seemed to last longer than the pressure itself, quite a little longer. It was clear and definite, but much less intense than the pressure; seemed to get nearer by jerks. Just as clear as actual pressure, only less intense. Remember surprise at feeling it before stimulus touched my hand." And again: "First felt pressure near third finger; then felt touch from first stimulus, much less intense than pressures in other experiments and not lasting so long. . . . The first [pressure] before the stimulus touched the hand . . . was like a big surface; seemed heavier than the two following [from stimuli], not so clear cut; other two real ones seemed less intense than the first. . . . All three seemed about the same in clearness. The first, *i. e.*, the one before the stimulus, seemed to be of longest duration. The two from the stimuli seemed to have smaller area."

Observer *K* reported: "Auditory perception of *E*'s voice. Some imagination, imagining what feeling would be like. Really, a tactual sensation before the stimulus was applied; rather diffuse, seemed much lighter, smaller, to cover less space than perception with stimulus. The real perception much clearer; following the perception was an after-image." *K* added that the 'imagination' of sensation before the stimulus was applied "would be as clear as a very light sensation produced by the instrument."

In these reports we have a mention of anticipatory 'images' which seem closely to simulate sensation.

Experiment II. Temperature

Cylinders 1 cm. in diameter were used; 35° C. was the standard stimulus, and the variable increased or decreased by 1° in successive trials. Instructions were as usual; the suggestion was repeated before every trial: "Towards the warmer," or "Towards the colder." The stimulus was applied for 2 sec.; the interval between stimuli was 5 sec. The inner side of the fore-arm was stimulated. Observers *A*, *B* and *C* took part in the experiment.

Suggestion Group

Observer *A* said after a few trials that he thought the stimuli of each pair were probably the same. However, with the suggestion "Towards colder" he judges 4° warmer as "colder;" 5° warmer as "equal;" and in another series, 3° warmer as "colder, doubtful." There were no supraliminal inversions when the second stimulus was colder.

Observer *B* with suggestion "Towards warmer" gives one inversion, at 2° colder. With suggestion "Towards colder" he judges 3° warmer as "colder" (twice), as "slightly colder" and as "equal."

Observer *C* with suggestion "Towards warmer" misjudges only once; 2° colder is called "warmer." With suggestion "Towards colder" he calls 3° warmer, "very decidedly colder;" 4° warmer, "very slightly colder or equal;" 6°, "equal;" 7°, "colder." After this judgment *C* said: "These judgments are more marked, the judgments more confident, than in the case of the visual sensations."

Control Group

Observer *A* several times reports anticipatory images. "*E*'s voice . . . in background; but was sufficient to arouse visual and tactual image of coming stimulus." Again: "Tactual image of how the stimulus would feel." Again: "*E*'s 'ready' and 'now' though heard inattentively caused increased strains and anticipatory tactual image." Once he speaks of a "tactual and cold(?) image."

After one of these reports, *E* asked *A* why he used the words "image" and "sensation" as he did. *A* replied: "If I had used the word 'sensation,' that would have meant that you touched me or that I thought you did. A touch sensation is different from a tactual image. I should say there is generally more of a sensation. I mean that the image is abbreviated, does not contain all that the sensation contains; perhaps, is of less extent, less intensity, generally, and I think (keeping this experiment in mind) that its extent is less clearly defined." After another experiment he remarked: "The criterion is probably the source of the stimulus, though why I answered as I did was probably unconscious."

Observer *B* reports: "Here I had a good anticipatory cold image, localized on the fore-arm before the stimulus was given. Verbal comment in imaginal terms: 'Why, here I am feeling cold.' Attitude of surprise." Asked why he used the word "image," *B* replied: "Might have been 'sensation' if the tactual sensations had also been present." In another trial *B* says: "Slight pressure and distinct warm sensations from the time *E* said 'now' up to the giving of the second stimulus." Here he uses the word "sensation."

Observer *C* reports "a diffuse cutaneous image of warmth in a certain cutaneous region of the forearm. Under the influence of the *Aufgabe* this became more intense." Again: "In mid-period kin-aesthetic-auditory images 'the next will be warmer;' then attitudinal process meaning roughly 'It is really so;' then cutaneous image of warmth, warmer than first [sensation] but not so warm as second proved to be; feeling of surprise." In differentiating between "sensation" and "image" at the time of these accounts, *C* said that, in the case of the sensation, there were other intermingled sensations. There was also a different attentional accommodation; the sensation was more intense and compact; the image was, as a rule, less intense.

Results of Experiment II

(1) The suggestion group shows inversions of judgment for all three observers; the judgments were made with full assurance, and in the face of some suspicion as to the nature of the experiments.

(2) The various types of judgment—motor, imaginal, sensory and mixed—are in this experiment fairly evenly represented.

(3) Anticipatory "images" of fair intensity play a part in the judgments.

E. DISCUSSION AND CONCLUSIONS

We have relied, in this paper, upon the reports of trained observers; and we have been obliged, in consequence, to utilize the observers *A*, *B* and *C* for experiments upon which they entered with definite suspicion. The effects of the verbal suggestions were thus, we may suppose, markedly lessened. Unless, however, we had the analyses given by these observers, we could hardly place any high degree of confidence in the positive statements of the less trained observers; types of judgment must be distinguished before interpretation is possible. It is regrettable that the limits of space have prevented our quoting in full some of the elaborate reports of the Control Group; still, enough has probably been given to indicate the general nature of the work.

Our first difficulty, then, lay in the necessity of recourse to trained observers. These men, just because they were trained, were less suggestible than the average and were likely to suspect the character of the experiments. A second difficulty arose from the necessity of prolonging the single observations. If a continuously changing color is to be wrongly 'seen,' or if a second noise is to be wrongly 'heard' in relation to a preceding noise, then the color must not change too quickly and the sounds must not occur in too quick succession. Our durations and intervals were chosen, after preliminary experiments, as times that should be long enough for the working of the suggestion and yet not so long as to preclude the possibility of a direct sensory judgment. We cannot pretend to have made them optimal; further work is desirable, with variation of times, just as further work is desirable with more trained observers and with other modes of stimulation.

Our positive results may now be summed up as follows:

(1) We have found three types of suggested consciousness, yielding three typically different kinds of judgment. (*a*) In some cases we note a carriage of the verbal suggestion, as if across the sensory contents, to the far end of the arc, i. e. to the motor expression of judgment. If it is too much to say that the sensory contents in such cases are irrelevant, we can

at least affirm that rather startling approximations to that state of affairs have occurred in the course of the experiments. The judgments of *B*, in particular, are largely of this type; they seem to represent the ripening of a motor impulse; they 'go off in a Yes' or 'say themselves.' It is hardly questionable that many instances of 'sensory suggestion' are, in reality, of this *motor* sort. (*b*) In other cases we note a free play of relevant imagery: of imagery that is largely due, in all probability, to the long-drawn-out character of the observations. The imagery clearly serves, in many instances, to furnish a new context or setting to the presented stimulus, and thus influences or determines judgment; in other words, the judgment expresses an imaginally modified situation, and does not bear directly upon the stimuli. Fully half of *C*'s judgments, and rather more than half of *E*'s, are of this *imaginal* sort. (*c*) In a third or *sensory* type of judgment, imagery is either lacking or fleeting and apparently irrelevant, while there is no indication of any motor impulse to express the suggestion. Judgments of this kind are the most frequent with the remaining observers and form (so far as we can judge) just over 40 per cent. of the total number of judgments passed in the Control Group. They alone can furnish evidence of a truly 'sensory' suggestion. (*d*) Lastly, there are judgments which cannot be placed outright under any one of these three rubrics, and that must therefore be classed as *mixed*. The combination imaginal-sensory is fairly common, and observer *A* gives a good number of judgments in which the sensory and the motor determinations are both involved.

(2) We have found sensory suggestion, vouched for by sensory judgments, with color and light (continuous change), with 'liminal' noise, with smell, taste and temperature. Our experiments with grey discs and tonal pitch (continuous change) were unsuccessful, mainly, it appears, by reason of the suspicion of the observers; those with visual extents failed, partly for the same reason and partly because the experiment favored other than sensory judgments; and those with noise intensities and pressures were inconclusive, because the experiments favored respectively motor and imaginal judgments. Other observers and other experimental arrangements might, of course, yield positive results. We have found, also, 'images' of touch, warmth and cold which simulate the corresponding sensations.

We do not hesitate to draw the conclusion that, in certain departments of sense, a verbal suggestion may arouse conscious processes which are, phenomenologically, identical with those

ordinarily aroused by an adequate stimulus or change of stimulus. The departments are those of sight, smell, taste and temperature. We think it probable that hearing and touch may be added to this list; but for those senses our evidence is incomplete or inconclusive. We have already pointed out, on the other hand, that many of the illusions ascribed to sensory suggestion by previous writers are of doubtful character. No observation may be put down as a case of sensory suggestion unless (*a*) the type of judgment is known to be sensory, and (*b*) changes of the sense-organ (adaptation, after-image, etc.) have been prevented by a fitting control of the experimental procedure.

We do not offer any physiological theory of our results, nor do we enter here upon the question of the relation of 'sensation' to 'image.' It would be premature to attempt a theory (or theories) on the basis of the present observational material; we still do not know, e. g., the qualitative range of color suggestion, or whether Baldwin's "red for green" is possible.

(3) No proof was needed that observers are 'suggestible.' We were, however, surprised at the potency of suggestion in the case of observers who had frankly avowed suspicion. *A* and *C*, the one unusually 'objective' and the other markedly 'subjective' in type, would both, again and again, 'accept' a suggestion against which they were, in general, on guard. We have here, then, a striking confirmation of a principle that of late years has won its way to recognition: the principle that the experimenter must exercise great care in the phrasing of his instructions, and must not be wearied of repeating them.

If we count the inverted judgments in the series which were taken both by men and by women, we find that the women have an excess of 3 per cent. In view of the lesser training of the women, we regard this difference as negligible.

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